Group of Governmental Experts of the High Contracting Parties to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects

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Humanitarian benefits of emerging technologies in the area of lethal autonomous weapon systems

Submitted by the United States of America

I. Introduction

Using Emerging Technologies to Limit Civilian Casualties Poses an Important Humanitarian Challenge

1. This working paper draws from existing State practice to identify potential humanitarian benefits of emerging technologies in the area of lethal autonomous weapons systems.

2. Civilian casualties are a tragic part of war. Although civilian casualties do not necessarily reflect a violation of international humanitarian law (IHL), protecting civilians from unnecessary suffering is one of the main purposes of IHL. Reducing civilian casualties promotes the objectives and purposes of the CCW, whose preamble recalls the "general principle of the protection of the civilian population against the effects of hostilities."

3. Emerging autonomy-related technologies, such as artificial intelligence (AI) and machine learning, have remarkable potential to improve the quality of human life with applications such as driverless cars and artificial assistants. The use of autonomy-related technologies can even save lives, for example, by improving the accuracy of medical diagnoses and surgical procedures or by reducing the risk of car accidents.[1] Similarly, the potential for these technologies to save lives in armed conflict warrants close consideration.

4. In particular, the United States believes that discussion of the possible options for addressing the humanitarian and international security challenges posed by emerging technologies in the area of lethal autonomous weapons systems in the context of the objectives and purpose of the Convention must involve consideration of how these technologies can be used to enhance the protection of the civilian population against the effects of hostilities.

[1] https://singularityhub.com/2017/11/30/the-doctor-in-the-machine-how-ai-is-saving-lives-in-healthcare/; https://spectrum.ieee.org/the-human-os/biomedical/devices/in-fleshcutting-task-autonomous-robot-surgeon-beats-human-surgeons; http://theinstitute.ieee.org/ieee-roundup/blogs/blog/ai-can-save-lives-by-taking-over-these-important-tasks.

5. This is especially the case because "smart" weapons that use computers and autonomous functions to deploy force more precisely and efficiently have been shown to reduce risks of harm to civilians and civilian objects.

6. The fundamental IHL principles of distinction and proportionality are consistent with military doctrines that are the basis for effective combat operations. Independent of legal considerations, sound military doctrine condemns the use of indiscriminate and excessive force as costly, inefficient, and a waste of scarce resources, and promotes discriminate uses of force as consistent with overarching strategic objectives. For example, in recent military operations to defeat terrorist groups in Iraq, U.S. commanders have sought to minimize the destruction to terrorist-controlled infrastructure in order to facilitate post-liberation reconstruction efforts. Military efforts to develop more precise and efficient weapons reflect a convergence between military effectiveness and humanitarian protection.

7. Existing State practice provides many examples of ways in which emerging technologies in the area of lethal autonomous weapons systems could be used to reduce risks to civilians: (1) incorporating autonomous self-destruct, self-deactivation, or self-neutralization mechanisms; (2) increasing awareness of civilians and civilian objects on the battlefield; (3) improving assessments of the likely effects of military operations; (4) automating target identification, tracking, selection, and engagement; and (5) reducing the need for immediate fires in self-defense.

II. Autonomous self-destruct, self-deactivation, or self-neutralization mechanisms

8. Autonomous self-destruct, self-deactivation, or self-neutralization mechanisms can be used to reduce the risk of weapons causing unintended harm to civilians or civilian objects. These mechanisms are not necessarily new, but they have become more effective with advances in technology.

9. For example, the Amended Protocol II to the Convention recognizes that self-destruction or self-neutralization mechanisms can help ensure that a mine will no longer function as a mine when the mine no longer serves the military purpose for which it was emplaced.

10. Similarly, the Hague VIII Convention Relative to the Laying of Automatic Submarine Contact Mines, October 18, 1907, also recognizes that naval mines and torpedoes should be constructed so as to become harmless after they have fulfilled their military purpose.

11. Although the United States is not a party to Convention on Cluster Munitions and does not regard its prohibitions as reflecting customary international law, that instrument recognizes that electronic self-destruction mechanisms and electronic self-deactivating features in explosive submunitions that are designed to be dispersed or released from a conventional munition can help avoid indiscriminate area effects and the risks posed by unexploded submunitions.

12. Apart from mines and bombs employing submunitions, a number of weapons systems can use self-destructing ammunition, which automatically destroys the projectile after a period of time so that it poses less risk of inadvertently striking civilians and civilian objects. For example, anti-aircraft guns often use self-destructing rounds to reduce the risk that shots that miss the target cause damage upon falling to the ground.[2] Similarly, U.S. Army engineers have worked to develop .50 caliber ammunition that would automatically disassemble after a certain distance to reduce the risk of collateral damage.[3]

13. More sophisticated autonomous self-destruct, self-deactivation, or self-neutralization mechanisms could be applied to a broad range of weapons to reduce the risk that weapons

[2] https://www.gd-ots.com/wp-content/uploads/2017/11/20mm-M940-Ammunition.pdf.

[3] https://www.army.mil/article/162556/.

may pose to civilians and civilian objects. For example, U.S. Department of Defense policy provides that measures be taken to ensure that autonomous or semi-autonomous weapon systems "complete engagements in a timeframe consistent with commander and operator intentions and, if unable to do so, to terminate engagements or seek additional human operator input before continuing the engagement."[4]

III. Increasing military awareness of civilians and civilian objects

14. Civilian casualties can result from a lack of awareness of the presence of civilians on the battlefield due to the "fog of war." For example, commanders might be unaware that civilians are in or near a military objective. Similarly, commanders might, in good faith, misidentify civilians as combatants – particularly when engaged in armed conflict against armed groups that go to great lengths to hide among the civilian population.

15. AI could help commanders increase their awareness of the presence of civilians and civilian objects on the battlefield by automating the processing and analysis of data.

16. One of the most ubiquitous and useful applications of AI has been to allow humans to search through large amounts of data to find relevant information quickly, such as through internet search engines. Companies are investing in AI to generate insights from "big data" with a view towards better serving their customers and increasing their profitability.

17. Commanders may similarly have an overwhelming amount of information to consider during military operations, such as hours of video from intelligence, surveillance, and reconnaissance (ISR) platforms.

18. The U.S. Department of Defense is engaged in an effort to use AI to improve its analysis of video from ISR platforms.[5] By using AI to identify objects of interest from imagery autonomously, analysts are able to search through larger quantities of data and focus on more sophisticated and important tasks requiring human judgment.

19. One of the results of improving the efficiency and accuracy of intelligence processes could be to increase commanders' awareness of the presence of civilians, objects under special protection such as cultural property and hospitals, and other civilian objects.

20. This increased awareness could help commanders better assess the totality of the expected incidental loss of civilian life, injury to civilians, and damage to civilian objects from an attack, including incidental harms that otherwise would not have been foreseeable. This increased awareness could also help commanders identify and take additional precautions, including by identifying additional property or areas that should not be attacked or that would require additional review or higher-level approval before being attacked.

IV. Improving assessments of the likely effects of military operations

21. AI could be used to improve the process of assessing the likely effects of weapons.

22. As part of targeting processes, military planners assess the likely effects of different types of weapon systems with a view toward minimizing collateral damage.

23. U.S. planners regularly use software tools in planning military operations to assist in assessing the likely effects of weapons, such as estimating potential collateral damage. The

[4] DoD Directive 3000.09, Autonomy in Weapon Systems, paragraph 4a(1)(b); *see also* enclosure 3, paragraph 1a(2).

[5] https://www.defense.gov/News/Article/Article/1254719/project-maven-to-deploy-computer-algorithms-to-war-zone-by-years-end/.

use of software tools allows estimates that once took hours or days to be generated in minutes.[6]

24. More sophisticated computer modelling software could help military planners more accurately assess the presence of civilians or predict the likely effects that the weapon would create when striking the military objective. Assessments could be generated more quickly and more often, further reducing the risk of civilian casualties.

25. Much like with improved military awareness of civilians and civilian objects, improved assessments of the likely effects of military operations could help commanders better assess the totality of the expected incidental loss of civilian life, injury to civilians, and damage to civilian objects from an attack, including incidental harms that otherwise would not have been foreseeable. Improved assessments could also help commanders identify and take additional precautions, including by selecting weapons, aim points, and attack angles that reduce the risk of harm to civilians and civilian objects, while offering the same or superior military advantage in neutralizing or destroying a military objective.

V. Automating target identification, tracking, selection, and engagement

26. Automated target identification, tracking, selection, and engagement functions can allow weapons to strike military objectives more accurately and with less risk of collateral damage.

27. Many types of missiles or bombs have "lock-on-after-launch" functions that allow the projectile to guide itself autonomously to targets after being launched by the human operator. The projectile has sensors that allow it to identify the target that the human operator intends to hit, and computers and guidance systems that allow it to select and engage that target. For example, the AIM-120 Advanced Medium-Range, Air-to-Air Missile (AMRAAM) incorporates an active radar in connection with an inertial reference unit and microcomputer system, which allows the missile to use its active radar to guide it to intercept its target.[7]

28. The use of munitions with guidance systems allows commanders to strike military objectives more accurately and with less risk of harm to civilians and civilian objects. Moreover, when the weapon is more accurate, fewer weapons need to be fired to create the same military advantage. A famous case study is of the Thanh Hoa bridge, which was a supply line used during the Vietnam War, and which was targeted by hundreds of U.S. sorties and bombs over seven years before being successfully destroyed by a handful of newly developed laser-guided bombs.[8]

29. Similarly, more accurate weapons can also allow for a smaller warhead to be used to generate the same military effect. For example, the GBU-53/B Small Diameter Bomb Increment II (SDB II) under development uses millimeter wave radar and imaging infrared sensors to find and identify targets, refine aim points, and guide the weapon to impact.[9] The approximately 200 lb. weapon includes capabilities for target search, classification, and prioritization, and its small warhead allows for targets to be hit with less risk of collateral

[6] http://www.defense-aerospace.com/article-view/feature/18894/usaf-plans-to-minimize-civilian-casualties.html; https://www.washingtonpost.com/archive/politics/2003/02/21/military-turns-to-software-to-cut-civilian-casualties/af3e06a3-e2b2-4258-b511-31a3425bde31/?utm_term=.ff1dd031bbda.

[7] http://www.navy.mil/navydata/fact_display.asp?cid=2200&tid=100&ct=2; http://www.navair.navy.mil/index.cfm?fuseaction=home.display&key=D3FAC4AB-2E9F-4150-9664-6AFBC83F203E; http://www.af.mil/About-Us/Fact-Sheets/Display/Article/104576/aim-120-amraam/; https://www.raytheon.com/capabilities/products/amraam/.

[8] https://media.defense.gov/2010/Oct/13/2001330008/-1/-1/0/AFD-101013-042.pdf; http://www.airforcemag.com/MagazineArchive/Documents/2011/August%202011/0811jaw.pdf.

[9] http://www.airforcemag.com/SiteCollectionDocuments/Reports/2010/August%202010/Day25/SDBII_factsheet_0810.pdf.

damage. As another example, the DAGR[8] missile also under development is designed to provide commanders the ability to strike high-value targets with less risk of collateral damage to civilians and friendly forces by delivering a 10 lb. warhead within one meter of the intended target.[10]

30. Automated targeting features are being developed for guns. For example, the Common Remotely Operated Weapon Station (CROWS) is a stabilized mount for weapons on vehicles that contains a sensor suite and fire control software.[11] CROWS features programmable target reference points for multiple locations, programmable sector surveillance scanning, automatic target ballistic lead, automatic target tracking, and programmable no-fire zones. A U.S. company, TrackingPoint, has recently developed a system that uses sensors and software to allow rifles to strike targets within one-half an inch at distances of one-half a mile.[12]

31. The addition of automated target detection and engagement functions can reduce the risk to civilians posed by weapons. As the Convention on Cluster Munitions recognizes, the use of explosive submunitions designed to detect and engage a single target object can be used to avoid indiscriminate area effects and the risks posed by unexploded submunitions. For example, the CBU-105 (Sensor-Fuzed Weapon) uses submunitions with advanced sensors to target precisely and engage enemy tanks and armored vehicles, rather than dispersing its submunitions in an unguided fashion.

VI. Reducing civilian casualties from the immediate use of force in self-defense

32. Emerging technologies could reduce risk of civilian casualties from the immediate use of force in self-defense.

33. Civilians are at increased risk in situations in which military forces are in contact with the enemy and respond to enemy fires in self-defense. In those operational situations, the imperative to take immediate action to counter a threat from the enemy reduces the time available to take precautions to reduce the risk of civilian casualties.

34. Existing practice, however, suggests that emerging technologies may offer a number of ways to reduce civilian casualties as a result of such engagements.

35. First, the use of robotic and autonomous systems can reduce the need for immediate self-defense fires by reducing the exposure of human beings to hostile fire.[13] For example, remotely piloted aircraft or ground robots have been used to scout ahead of forces conducting patrols in environments where they might be surprised by enemy ambushes or roadside bombs. Robotic and autonomous systems can provide a greater standoff distance from enemy formations, allowing forces to exercise tactical patience to reduce the risk of civilian casualties.

36. Second, technologies to identify automatically the direction and location of incoming fire can reduce the risk of misidentifying the location or source of enemy fire. For example, the Lightweight Counter Mortar Radar can identify indirect fire threats by automatically detecting and tracking shells and backtracking to the position of the weapon that fired the shell. Similarly, the "Boomerang" detection system uses microphones and computers to identify the source of incoming gunfire in less than a second.[14]

37. Third, the use of defensive autonomous weapons, such as the Counter-Rocket, Artillery, Mortar (C-RAM) Intercept Land-Based Phalanx Weapon System, used to counter

[10] https://www.lockheedmartin.com/content/dam/lockheed/data/mfc/pc/dagr-mfc_dagr-pc.pdf.

[11] http://www.dote.osd.mil/pub/reports/FY2012/pdf/army/2012crows.pdf; https://en.wikipedia.org/wiki/CROWS.

[12] https://www.tracking-point.com/technology/how-it-works/.

[13] http://www.tradoc.army.mil/FrontPageContent/Docs/RAS_Strategy.pdf.

[14] https://www.raytheon.com/capabilities/products/boomerang.

incoming rockets, mortars, and artillery, can provide additional time to develop a considered response to an enemy threat.

VII. Conclusion – Entirely new capabilities

38. The examples that we have discussed help illustrate the potential of emerging technologi in the area of lethal autonomous weapons systems to reduce the risk of civilian casualties and damage to civilian objects, but it is important to recall that technology is often applied in innovative ways that are wholly unlike previous applications.

39. Emerging technologies in the area of lethal autonomous weapons systems could be used to create entirely ew capabilities that would increase the ability of States to reduce the risk of civilian casualties in applying force.

40. Rather than trying to stigmatize or ban such emerging technologies in the area of lethal autonomous weapon systems, States should encourage such innovation that furthers the objectives and purposes of the Convention.